

Learning's from teaching "EE292L: Nanomanufacturing" using an adapted flip classroom model

- Aneesh Nainani (nainani@stanford.edu)

1. What do you mean by adapted flip class room format?

For each week i posted around 10 short screencast videos totaling 60-90 minutes of content on the class website (nano.class.stanford.edu) and YouTube (see a brief montage here: <http://bit.ly/PIRc4b>). Through the course of the fall quarter I produced around 100 of these videos for the class, each ~10-15 minute long.

Use of these videos freed up the classroom time, which we used to have interactive sessions and guest lectures from leading engineers in semiconductor startups, big companies and venture capital firms focused on nanomanufacturing/nanotech. Each of the guest lectures was deeply tied to the class content. We still used ~40% of the class time for lectures which supplemented these online videos. We also recorded and produced all the guest lectures and tried to make them available by Monday for the previous week.

We chose this format as it best suited our class goals, one of which is to generate enthusiasm among students towards the field of nanomanufacturing and semiconductor technology. Using 40% of classroom time for teaching still allows us to teach the content which is copyrighted and not suitable for placing in public domain. The guest lectures on the topics, immediately after we covered them in class, exposed the students to some of the key problems in the field and painted a bigger picture, so to speak.

2. What insights did you gain by looking at the data collected on video usage?

Looking at the number of views and minutes of videos watched by the students' gives the instructor great insight into things like: which are the days when students are engaging most with the content, what is the average time they are spending per week watching the videos etc. For example, given below is the graph I have taken from the analytics that YouTube offers and overlaid them with the problem set and midterm deadlines of the course. It once again indicates that procrastination is a universal phenomenon and you see clear peaks around the deadlines.

It also helps you visualize how the workload / engagement is spread out throughout the quarter. Also looking at the data in Figure 1 and collaborating with an engagement matrix, we realized that we ended up making the course more front loaded, with no endterm the video views dropped in the last 2 weeks of the course, after thanksgiving break. Looking at this data we can now sync the video uploads and the course deadlines such that it creates a more even pattern in the future offerings of the course.

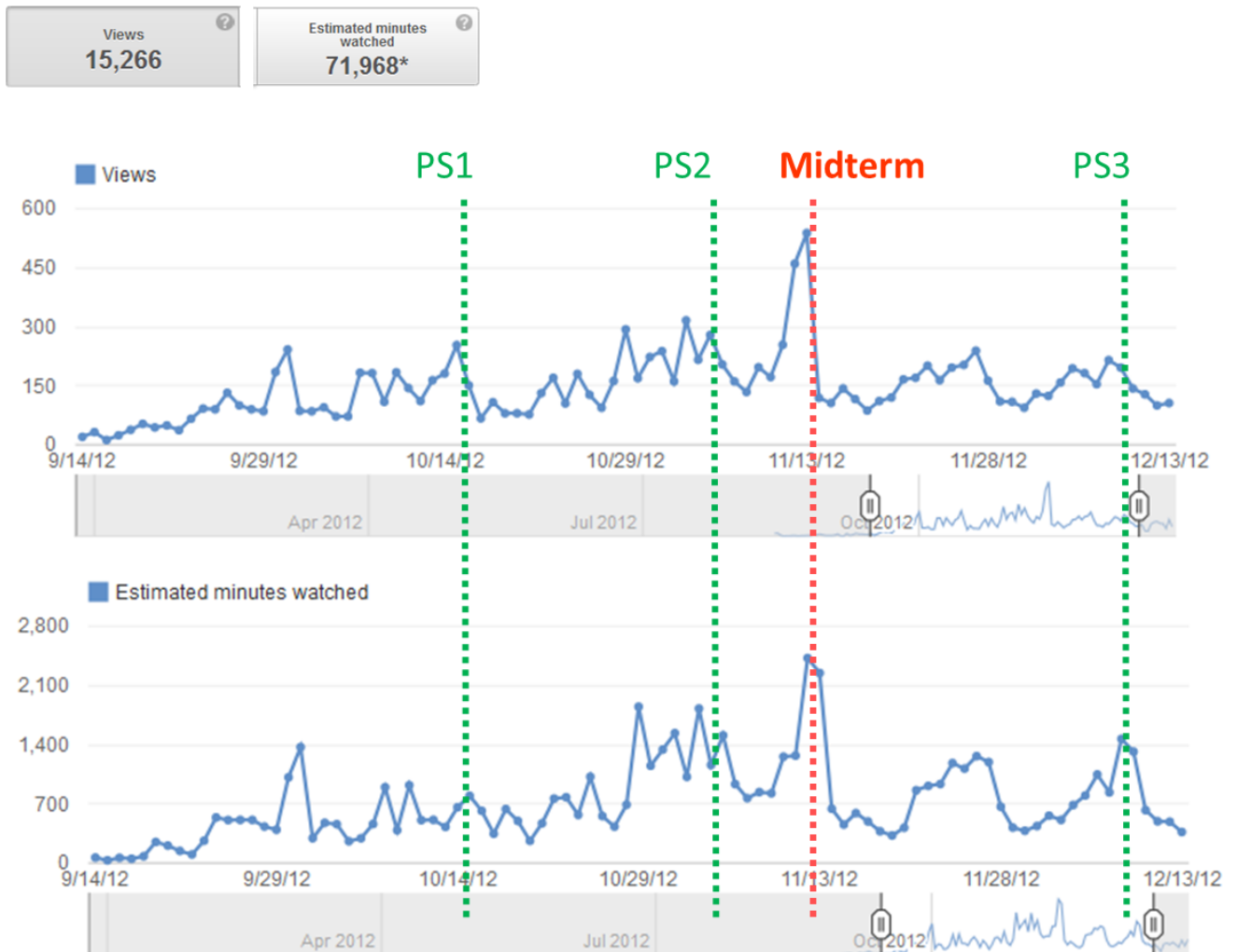


Figure 1: Number of views (top) and minutes (below) of video watched each day during the Fall quarter period.

We decided to place the screencast videos and recording of guest lectures in the public domain via YouTube. This allowed us to collect statistics on how the videos are being watched around the world as well, as shown in Figure 2. Which also highlighted a weakness is associated with the use of YouTube as the only platform for viewing the videos, which makes them largely unavailable in China. This was pointed out to us by one of the students when he traveled there during the course of the quarter, and is clearly visible in the data below.

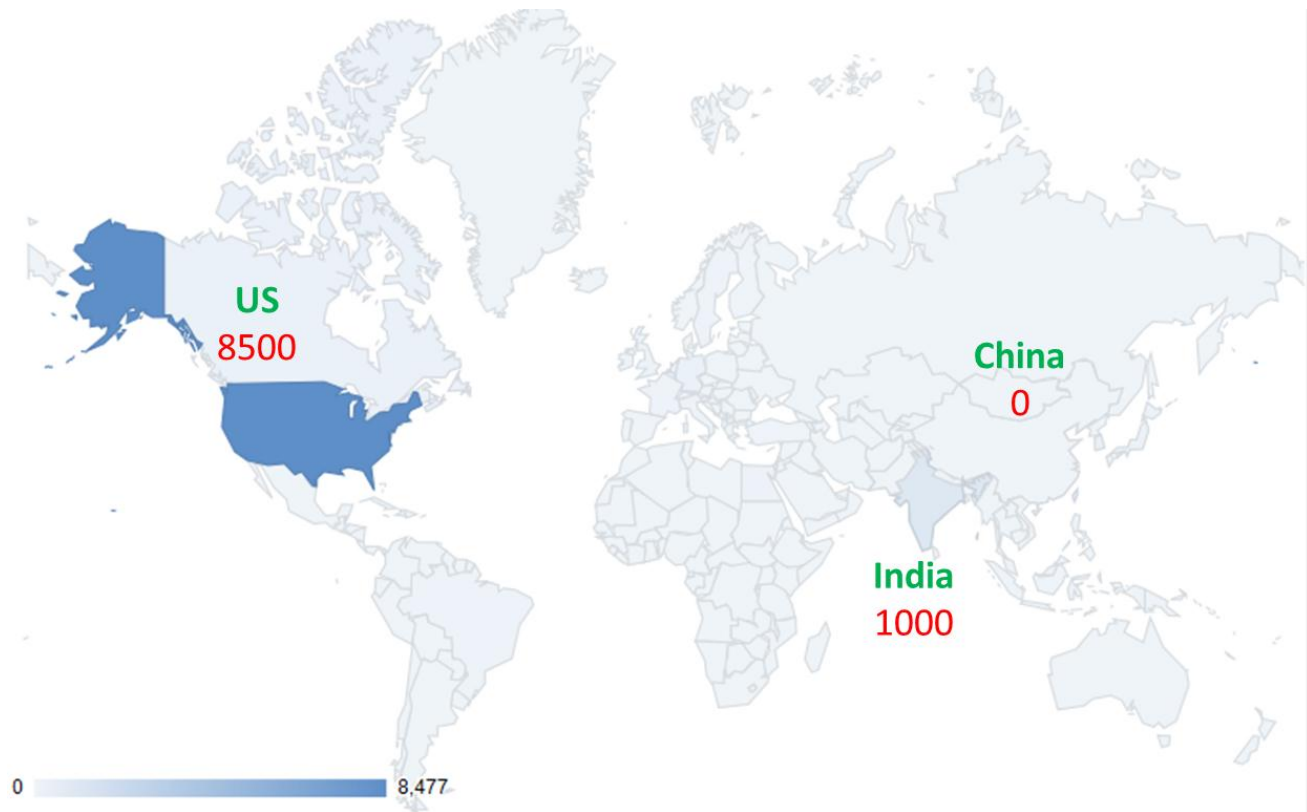


Figure 2: Number of views on videos which were publicly available on YouTube in a 7 week period

3. What other innovations did you introduce in the class?

Peer Graded Video Project

As many of you know EE is in dire need of more killer projects to drive student engagement. We introduced a video project, where the students were asked to produce a short screencast video. We floated 11 topics for the project, and no more than 4 students could work on a particular topic. The topics were selected such that they expanded on the topics which were taught in class or topics which were intentionally left out for peer-learning. The only boundary condition on the video was that it has to be between 10-15 min long.

Peer-grading was used for grading the videos, where video submitted by each student was graded by 20 of his peers, who were asked to give it a score and submit comments on the technical depth and creative components in the video. For each student it corresponded to watching 20 of these videos, around ~4hr of content. Each student got to watch and rate at least 2 videos on each topic. The comments collected were compiled and shared with the students anonymously. Many students gave us the feedback that they had renewed appreciation for the class videos after producing one on their own, and greatly appreciated the comments they received on their work.

I was greatly impressed with the creative talent and technical depth, which came across in many of the videos. Few of the best rated videos as judged by the class are given below.

1. Antonio Gellineau: Mirasol Display

Link: <http://bit.ly/TKAKsF>

Score (Technical/Creative/Overall): 8.4/8.6/89.5

2. Kye Okabe: STT RAM

Link: <http://bit.ly/Qlqi7t>

Score (Technical/Creative/Overall): 8.8/7.4/86.7

3. Cathy Jan: Strain Engineering for Transistors

Link: <http://bit.ly/VkUMt8>

Score (Technical/Creative/Overall): 8.1/8.2/87.05

4. Charu Govindarajan: Carbon Nanotubes in FETs

Link: <http://bit.ly/TDkAAN>

Score (Technical/Creative/Overall): 7.7/8.7/87.4

5. Chien-Yu Chen: Monolithic 3DIC Process: Heteroepitaxy and Wafer Bonding

Link: <http://stanford.io/WKej7h>

Score (Technical/Creative/Overall): 7.9/8.1/86

The complete list of videos produced by the class with clickable links can be seen here

<http://bit.ly/XsaHg6>

Soft copy submission for problem sets

Currently, there is lot of administrative overhead on behalf of admins, students, TAs and graders which goes into collecting hard copies of problem sets and distributing them back. In my class this quarter, we gave the students the option of submitting the problem sets by email, with the promise that we will grade them and return them back faster as compared to the hardcopy ones. A simple email list was used for submission such that the submission was received by the instructor, TA and grader simultaneously. We also pointed the students to freely available apps on both iOS/Android which they can use to convert their handwritten work into a merged pdf.

50% of the class took up the offer on the first problem set which increased to 85% for the third problem set. Besides being green, this allowed us to gain insight into the thought process of students and browse the varied responses we received to a question. This was very useful in figuring out what didn't work and which questions need to be redesigned next year. In my opinion this creates a very useful database for the instructor, which didn't exist before. In some instances we included the student answers as best solutions while creating the solutions for the problem sets.

4. What was the feedback you received?

	Response Rate	Mean	Median	Std Dev	Ex	Vg	G	F	P	N/A
Course	70%	4.45	5.00	0.62	15	12	2	0	0	0
Instructor	70%	4.38	4.00	0.67	14	12	3	0	0	0

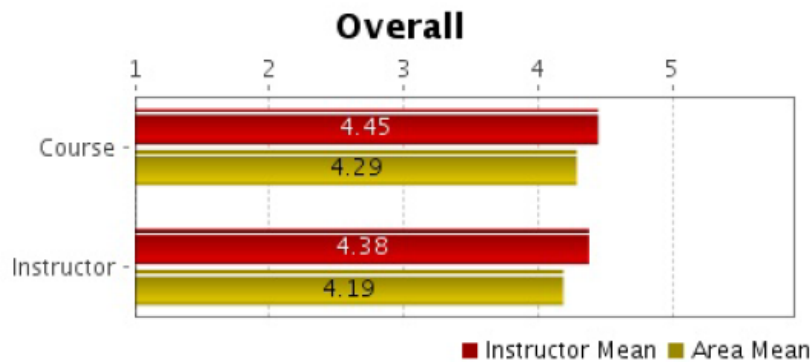


Figure 3: Student feedback on Axxess

The recording of the classroom lectures which included guest speakers turned out to have several advantages, even for an on campus class, some of which are described below

- At the beginning of the class we had a student who was stuck in China due to visa issues. He was able to follow the class and keep on top of the material and problem sets by downloading the class lectures and short videos available on the class website.
- The posting of the class room lectures online did not result in attendance going down in regular class. We still got ~80% attendance for lectures and guest lectures, which we tried to make interactive by doing demos etc. For e.g. we did a teardown of the newly released iPhone 5 in first week of class which was a big hit (see video here: <http://bit.ly/TrEqmJ>).
- The students found the availability of classroom videos particularly helpful to look back at the material in case they had to miss a class. For e.g. we had several senior PhD students who took the class and had to miss lectures due research and other commitments which become frequent towards the latter years of your thesis, who in particular appreciated the availability of the videos
- The recording of class lectures allowed us to keep the slides simple and clutter free. In several courses the lecture slides often serve the dual purpose of teaching and being the reference material. The latter many a times requires the instructors to either cram a lot of text and citations into the slides, which can compromise its use for classroom teaching or spend a lot of time and effort preparing class notes which accompany the slides. In our case, we could speak to the slides and give the references and additional information during the lecture, and be ensured that the students can refer to it when needed. We emphasized this point to the guest lecturers as well and asked them to keep the slides simple with minimal text.

- Recording of the guest lectures and making them available to a public domain helped us to attracting great guest speakers and also allowed us to push them to put that little extra effort in preparing the lecture, as the talk was to be recorded and made available for eternity on the internet. For example, we had guest lectures from the founders of 4 of recent semiconductor startups: Soraa, Solixel, Solar Junction, Techsearch, 2 which of gave detailed description of their technology for the first time in a public forum using this class.
- Lastly, besides being useful for the students, these recordings are of great value to the lecturer as well. I can for example go back and look the lecture to see how I paced it, what worked and what didn't and then tailor the content for the subsequent classes.

5. Advice to other instructors who want to use this format ?

I found the process of creating these short screencast videos to be inexpensive, time consuming yet rewarding at the same time. My main advice for instructors trying to use this short video format is that, you need to re-design the course material from grounds up, to be effective for this format. If we take an hour long lecture and manually chop it into 10-15 minutes segments it would not be nearly as effective. It will be most effective if each of the short videos is nearly self-contained and contains one or maximum of two concepts. Similarly it would be much more effective if you storyboard each of videos, think of it as a short story where it needs to have an epilogue, elements of humor and andragogy and an ending. Note that while I recommend putting some effort into structuring the video, I would not recommend writing the whole script, which cuts out the spontaneity and the conversational element in the videos.

It takes a lot of effort to run a course in this format. I storyboarded each of these short videos, and it took me ~10hrs to prepare and produce one hour of content (although things got better as the weeks progressed and I gained more experience). The second most consuming part was co-coordinating the guest lectures, such that they were in sync, yet not overlapping with what had been covered in short videos and class. To ensure that the guest lectures were closely tied to the class, we provided the speakers with guidelines and tips, asked them to watch the short videos ahead of the class and worked with them much ahead of their lecture. Inviting and co-coordinating 10 guest speakers for the quarter turned out to more time consuming than what we had imagined. I am hopeful this will pay off in the long run though.

Useful resources

1. Platform used for hosting the class videos: Class2Go (class2go.stanford.edu)
2. We provided the students with loaner iPadd for the video project. More information on that can be obtained here: <https://acomp.stanford.edu/faculty/ipadsforlearning>
3. Resources from Vice Provost of Online Learning (<http://online.stanford.edu/resources>)
4. Free Apps for creating screencast videos on iPad: Educreations (<http://www.educreations.com/>) , Docreri (<https://itunes.apple.com/us/app/doceri/id412443803?mt=8>)